General Andrew Jackson

Small Scale Residential PEM Fuel Cell Demonstration Program Fort Jackson, SC

LOGANEnergy Corporation
Initial Project Description
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Fort Jackson, SC

Contents

1 Introduction

Fuel Cells convert the chemical energy of a fuel into useable electric and thermal energy without an intermediate combustion or mechanical process. In that respect, they are similar to batteries. However, unlike batteries, fuel cells oxidize externally supplied fuel and therefore do not need recharging. Ever since National Aeronautics and Space Administration (NASA) adopted fuel cell power for the Apollo Space program, American industry has been fascinated by the prospects for their use on earth as well.

When integrated with a fuel processor and a solid-state power conditioner, the power system becomes one that produces clean, quiet and reliable electric power and heat. Several manufacturers are currently hard at work to translate the basic technology into consumer products. As advances in PEM technology and mass production converge to introduce competitively costs systems into the marketplace, many are betting that small scale fuel cell generators will soon be ready to tackle thousands of residential and small scale commercial power applications. These new appliances will be packaged energy systems providing both heat and electricity that will be able to operate with or without the local utility grid.

Until recently, however, the promise of fuel cell technology has been slow to advance beyond a narrow beachhead commonly referred to as the "early adopter" marketplace. Broader market appeal has been constrained by fits, false starts and premature expectations raised by eager manufacturers; but also high prices, skepticism, and not a little resistance by parochial interests have all restricted the opportunity. Notwithstanding, during the decade of the 1990s, the UTC PC25C Fuel Cell program, largely assisted by a significant investment by DOD, gradually established a solid record of achievement and customer satisfaction at numerous US locations and around the world. Installations sites included military hospitals, commercial buildings, banks, food processing facilities, data processing centers, police stations, and airports.

While many of these "early adopters" hosted pure technology demonstration projects, the industry gained valuable experience and knowledge because of them. More recently, however, customers have warmed to the proposition that fuel cells have real performance advantages in various combined heat and critical power applications (CHP). Perhaps their attitudes and business practices may be adjusting to accommodate an uncertain energy landscape. Clearly, many energy providers are scrambling to maintain their market base, others are floundering, and still others are stalking new opportunity. Nevertheless, they are all discovering that informed consumers have gained new leverage through the power of choice. Increasingly, newspaper articles, periodicals and other media outlets are scoring direct hits with stories about fuel cells. Policy makers are out front raising expectations of a cleaner highly efficient fuel cell / hydrogen based economy of the future. The signals are clear. Initiative and momentum are driving a rapidly maturing fuel cell industry.

Certainly one reason is because fuel cell technology represents, perhaps, the most exciting and innovative development in the energy industry today. In some ways the technology is maturing more rapidly and markets are developing more quickly than the supporting infrastructure, codes and standards are able to accommodate. However, as technology demonstrations increasingly give way to CHP fuel cell installations that provide practical solutions to demanding consumer requirements, such roadblocks should get resolved as consumer and utility interests find common ground. For example, in most applications, large-scale fuel cell installations may off-load significant power resources during critical grid demand intervals, serving utility interests, while providing "hot" back-up for mission essential loads in commercial and even residential applications. Additionally, they may also provide thermal Btus for heating and cooling loads-demonstrating the dual benefits of enhancing grid stability and promoting energy conservation.

At the small scale and residential end of the fuel cell spectrum, the opportunity is just as promising for the rapid expansion of distributed power generation. Conceivably, thousands of 3kW to 5kW CHP fuel cells in homes and small businesses across the country could within several years displace hundreds of MWhs of electricity and millions of thermal Btus with clean, efficient and reliable energy service. If this occurs, it could have a dramatic impact on both the energy industry, and on the nation's economy and security. Consumers, not utilities, could begin displacing environmentally disruptive generation methods, thereby forcing changes in the industry. As providers of grid resources, they may one day collectively enhance grid stability in many areas, boosting efficiency and conservation norms, and having a decided impact on the evolution of national energy policy.

Against this backdrop, the US Army Corps of Engineers, Construction Engineering Research Lab (CERL) has contracted with LOGANEnergy Corporation to engage a progressive fuel cell energy strategy to inform future DOD policy and planning. Broadly speaking, this engagement directs LOGAN to purchase and install residential and small-scale fuel cell power plants, and then test and evaluate their performance in widespread applications at selected military installations. Three seemingly incongruous events make this program very timely. They are (a) the complexities and perplexities of utility deregulation juxtaposed with, (b) base utility privatization programs, and (c) the nascent interest in distributed generation / CHP technologies that promise more efficient utilization of resources.

If the fuel cell industry appeared very much ahead of a languid power market in the recent past, today those markets are in comparative turmoil. Prices and availability, in some cases, are volatile and beyond the comprehension of energy managers and consumers alike. Consumers who are seeking innovative and efficient energy solutions for greater comfort, convenience and reliability are adding a new urgency. If the fuel cell industry can capitalize on these conditions, it will have a rich market opportunity, but it will have to deliver energy services and benefits that are immediate, site specific, cost effective, energy efficient, and certifiably green!

In order to test and evaluate the state of PEM fuel cell technology against these challenges, LOGANEnergy Corporation will demonstrate over the course of a year a PEM small scale fuel cell at Ft Jackson, SC. The project will be guided by an operations plan that will direct the installation, testing, evaluation and reporting on the performance of the unit. The objectives of the plan include;

1. Evaluating installation methods in order to help standardize safe and cost effective installation practices,
2. Evaluating "out of the box" reliability and interoperability with existing facility electrical and mechanical systems / infrastructure,
3. Evaluating actual PEM operating characteristics as compared to manufacturer representations,
4. Measuring the cost of operating a PEM unit under real market conditions,
5. Measuring, collecting and analyzing operating data including, total load hours, availability, kW production, fuel consumption, water consumption, forced outages, serviceability, and manufacturer's support.
6. Introducing PEM technology, power distribution and energy efficiency to DOD and local stakeholders in the community.

The project will be led by LOGANEnergy and supported by energy professionals within the fuel cell manufacturing and the fuel cell application/ service industry, including Plug Power and Energy Signature Associates.

2 Ft. Jackson Site Selection

In March 2002 LOGAN contacted Mr. Jerry Fuchs, utility engineer at Ft. Jackson, SC to introduce the CERL Small Scale Residential PEM Fuel Cell Program. As a result of the conversation, Mr. Fuchs invited LOGAN to visit the base in April 2001 to make a PEM fuel cell presentation to facility engineering. A month later, Mr. Fuchs informed LOGAN that Ft. Jackson would like to be considered as a host site in the PEM program. In September 2001, CERL advised LOGAN that Ft. Jackson would be selected in the FY'01 PEM demonstration program.

In February 2002, DCH Enable, who was to provide the fuel cell for FT. Jackson, notified LOGAN that they would not be able to fill the order. Fortunately, Plug Power agreed to fill the need, and LOGAN subsequently contracted with Plug to supply a 5kW GenSys5C for the Ft. Jackson project.

Some months later, in mid August 2002, LOGAN and CERL personnel met at Ft. Jackson to discuss the demonstration project with Jerry Fuchs and Col. Johnson, the garrison commander. During the discussion, Col Johnson volunteered his personal residence to be the installation site. After a brief visit to his residence, it was decided to accept his offer to install the fuel cell there. Figure 1 and Figure 2 are photos of the fuel cell on its pad at Col. Johnson residence.

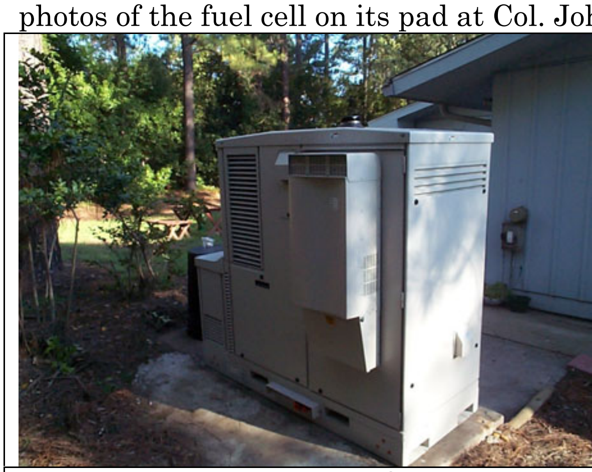


Figure 1. Fuel cell on its pad at Col. Johnson residence.

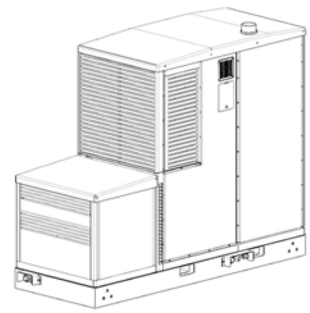
Figure 2. Fuel cell on its pad at Col. Johnson residence.

The site provides a significant opportunity for the program, as it represents a real world scenario. The back yard and patio are to the rear of the fuel cell. Natural gas is conveniently located within 25 feet of the fuel cell pad, and the residential equipment room housing the hot water heater, electrical panel, and water source are also close and accessible.

In Figure 2, at right, another view of the installation shows the fuel cell sitting on a pad previously occupied by a 2-ton residential air conditioning unit. The fuel cell was rigged onto the pad with the assistance of a commercial fork truck. Note the compost bin to the right of the fuel cell. Screening shrubbery will be planted around the fuel cell.

3 GenSys5C Product Specifications

The GenSys5C is a 5kWAC on-site power generation system fueled by natural gas. Designed to be connected to the existing power grid, the 5C is a clean and efficient

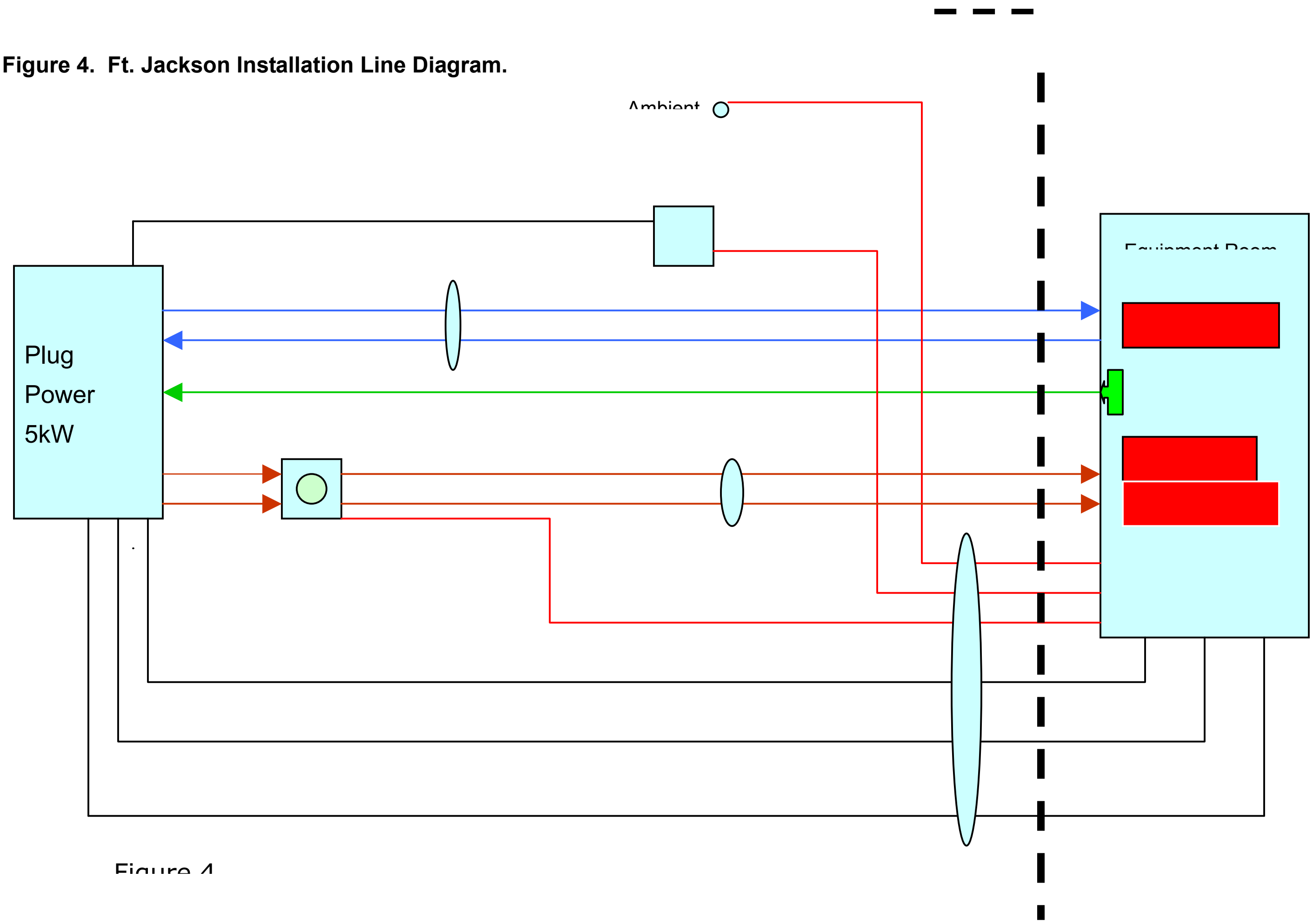


Specifications

Physical	Size (L X W X H):	84 1/2” X 32” X 681/4”
Performance	Power rating:	5kW continuous
	Power set points:	2.5kW, 4kW, 5kW
	Voltage:	120/240 VAC @ 60Hz
	Power Quality:	IEEE 519
	Emissions:	NO_X < 5ppm
		SO_X < 1ppm
		Noise < 70 dBa @ 1meter

Figure 3. GenSys5C Product Specifications

Figure 4. Ft. Jackson Installation Line Diagram.



Installation Application

Figure 3, above, lists the specifications of the Plug Power GenSys5C PEM technology demonstration fuel cell unit for this installation. Figure 4, above, diagrams the fuel cell installation with utility interfaces including, power and water in the adjacent residential room. The natural gas piping run is approximately 25 feet, the R/O water-piping run is approximately 25 feet, and the electrical and thermal recovery conduit runs are approximately 25 feet.

The fuel cell inverter has a power output of 110/120 VAC at 60 Hz., matching the residential distribution panel in the mechanical room with its connected loads at 110/120 VAC. The fuel cell will be installed in a grid parallel/grid independent configuration as indicated in Figure 4. A two-pole wattmeter will be installed on the grid parallel and grid independent lines to record fuel cell power delivered to both the existing power panel and the new critical load panel to be installed in the equipment room.

Gas will be supplied from a gas meter adjacent to the fuel cell pad as indicated in Figure 4. A regulator will be installed at the fuel cell gas inlet to maintain the correct operating pressure, and a new gas meter will be installed on the fuel cell line to record the gas volume consumed by the fuel cell.

A Reverse Osmosis water filtration system will be installed in the equipment room to provide filtered process water to the power plant. Water will be piped to the fuel cell as indicated in Figure 4 above, and a heat strip will wrap the piping to prevent freezing. A Bradford Johnson Combi-Coil hot water heater with an internal heating coil will replace the existing hot water heater so that fuel cell waste heat can be provided to the residence. A BTU meter will be installed on the thermal recovery system to record waste heat utilization by the residence.

A phone line will be provided to the fuel cell modem to establish communications with Plug Power and LOGAN customer support functions.

The project required the procurement of two construction permits. A digging permit was issued by Ft. Jackson, and air quality permit was issued by the South Carolina Department of Health and Environment. Ft. Jackson personnel performed an asbestos investigation prior to allowing the project to begin.

Prior to starting the unit the items covered in Figure 5, below, will be completed. Then, once the unit has started, the unit will be tested and monitored in accordance with the factory recommended procedures listed in Figure 6, below.

Service incidents and facility calls will be reported on the sample Service Call Report form listed below as Figure 7.

An Economic Analysis of the Ft. Jackson RESSDEM project appears in Figure 8.

TASK	SIGN	DATE	TIME(hrs)
Batteries Installed			
Stack Installed			
Stack Coolant Installed			
Air Purged from Stack Coolant			
Radiator Coolant Installed			
Air Purged from Radiator Coolant			
J3 Cable Installed			
J3 Cable Wiring Tested			
Inverter Power Cable Installed			
Inverter Power Polarity Correct			
RS 232 /Modem Cable Installed			
DI Solenoid Cable Installed with Diode			
Natural Gas Pipe Installed			
DI Water / Heat Trace Installed			
Drain Tubing Installed			

Figure 5. Installation check list.

TASK	SIGN	DATE	TIME (hrs)
Controls Powered Up and Communication OK			
SARC Name Correct			
Start-Up Initiated			
Coolant Leak Checked			
Flammable Gas Leak Checked			
Data Logging to Central Computer			
System Run for 8 Hours with No Failures			

Figure 6. Commissioning check list.

SERVICE CALL REPORT **SYSTEM INFORMATION**

System Serial #: ______________________________ Date ________

Purpose of Service Call: ☐ ***Repair*** ☐ ***Maintenance*** ☐ ***ECN*** ***(Check all that apply)***

	Date	**Time**
Date/Time shutdown	________	________

MAINTENANCE / REPAIR INFORMATION

Service Tech Name: ______________________________

Travel Man-hours: ____________

Troubleshooting Manhrs: ____________

Repair Man-hours: ____________

Spare Part Delay Time: ____________

Work Performed: ____

____

Technician

Comments:

FAILURE REPORT SUMMARY

Date	Description of Problem	Rpt #	Initials

Figure 7. Failure report summary.

LOGANEnergy Corp.

FY' 01 RESSDEM

Ft Jackson PEM Fuel Cell Economic Analysis

Utility Rates	
1) Water (per 1,000 gallons)	$1.69
2) Electricity (per KWH)	$0.0651
3) Natural gas (per MCF)	$5.80

Estimated First Cost	
Plug Power 5 kW SU-1	*$75,000*
Shipping	*$1,800*
Installation electrical	*$4,200*
Installation mechanical	*$7,000*
Watt Meter, Instrumentation	*$3,750*
Site Prep, labor materials	*$925*
Technical Supervision	*$8,500*
Total	***$101,175***

Assume Five Year Simple Payback	**$20,235**

Forcast Operating E	**Volume**	**$/Hr**	**$/ Yr**
Natural Gas			
Mcf/hr @ 2.5kW	*0.032838*	*$0.19*	*$1,502*
Water			
Gals/Yr	*4918*		*$8.31*

Add Total Annual Operating Costs	**$1,510**
Total Annual Costs (Ammortization + Expenses)	**$21,745**

Economic Summary		
Forcast Annual kWH	*19710*	
Annual Cost of Operating Power	*$0.0766*	kWH
Credit Annual Thermal Recovery	*-0.01649*	kWH
Project Net Operating Cost	*$0.0601*	kWH
Ammount Available for Financing	*$0.0050*	kWH
Add 5 Yr Ammortization Cost / k	*$1.0266*	kWH

Current Demo Program Cost Assuming 5 Yr Simple	**$1.1032**	**kWH**

***NOTE**Does not include allowance for cell stack life cycle costs or service over 5 year economic senario*

Figure 8. Cost summary (editor added this caption).

4 Project Contacts

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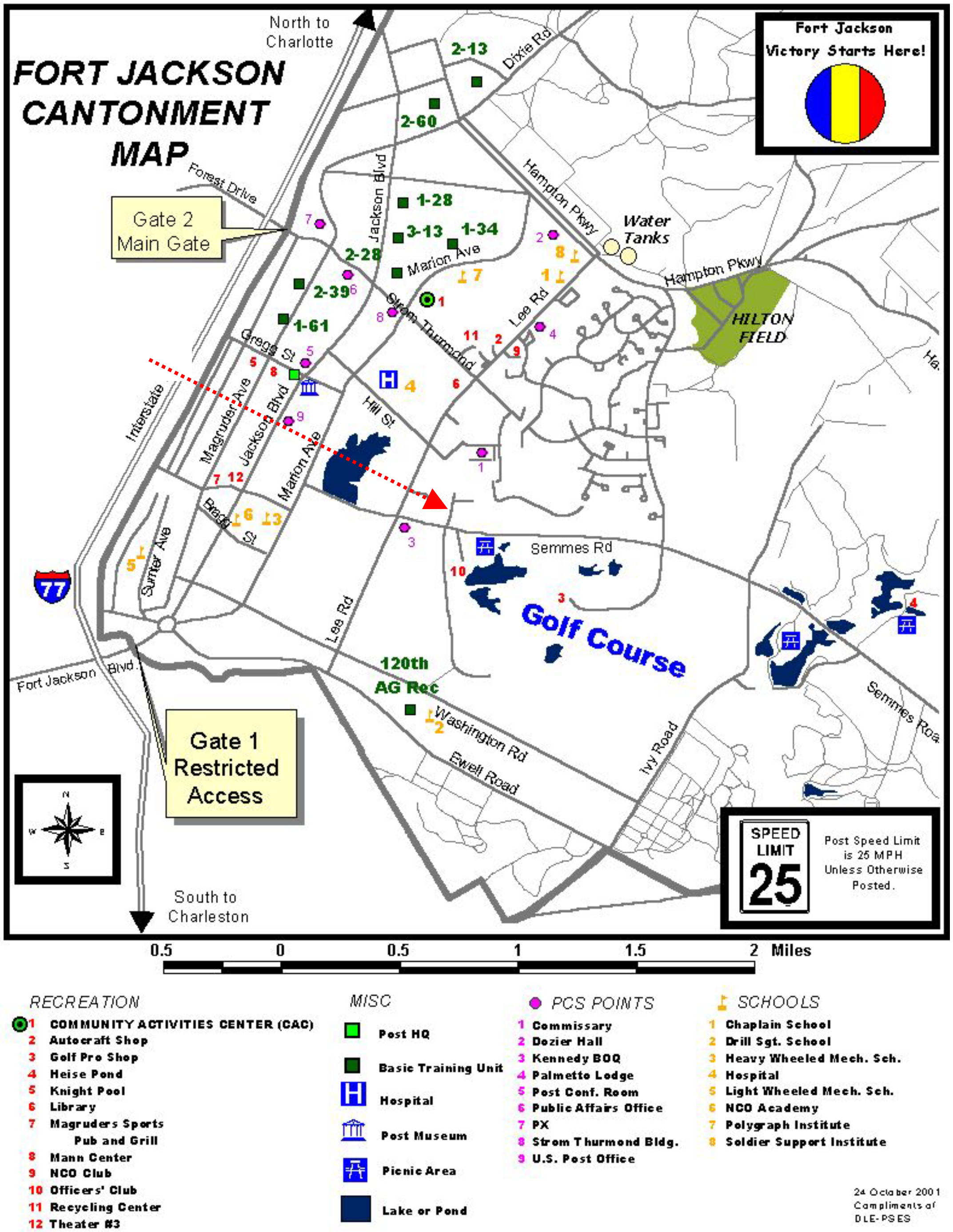

Figure 9. Fort Jackson cantonment map.